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First record of *Lutjanus madras* (Perciformes: Lutjanidae) from the Pacific Ocean, with comments on its intraspecific morphological variation

by

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Résumé. – Premier signalement de *Lutjanus madras* (Perciformes : Lutjanidae) dans l'océan Pacifique et commentaires sur les variations morphologiques intraspécifiques.

Le vivaneau madras *Lutjanus madras* (Valenciennes *in* Cuvier & Valenciennes, 1831), jusqu'à présent connu uniquement dans l'océan Indien, a été signalé dans l'océan Pacifique centre-ouest sur la base d'un spécimen unique (221,3 mm de longueur standard) collecté à l'île de Panay, République des Philippines. Cette observation suggère que cette espèce a une répartition géographique plus importante que celle qui était précédemment reconnue, s'étendant au-delà d'une barrière biogéographique bien établie pour les organismes marins. Les variations morphologiques intra-spécifiques de cette espèce sont également discutées.

Key words. – Lutjanidae - *Lutjanus madras* - Indo-West Pacific - Range extension - First record.

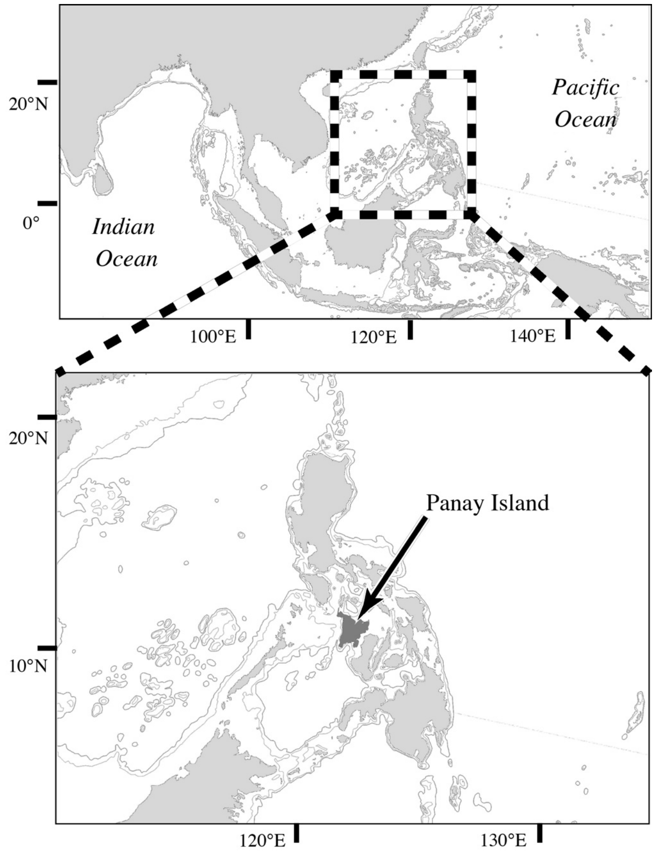

Figure 1. – Sampling locality of the present specimen of *Lutjanus madras*.

The genus *Lutjanus* Bloch, 1790 consists of 70 valid species, representing the most species-rich genus of the family Lutjanidae (Nelson *et al*., 2016). Primarily exploiting coastal habitats, most of the species of the genus from Indo-Pacific or Indo-West Pacific region are widely distributed across the tropical and subtropical, and some species exhibit significant population differentiation associated with biogeographic barriers (*e.g*. *Lutjanus erythropterus* Bloch, 1790 and *L. malabaricus* (Bloch & Schneider, 1801): Salini *et al*., 2006; *L. kasmira* (Forsskål, 1775): Gaither *et al*., 2010).

Lutjanus madras (Valenciennes *in* Cuvier & Valenciennes; 1831), originally described from a single specimen from Mahé, Seychelles, in the Indian Ocean, was thought to be widely distributed across Indo-West Pacific. After being diagnosed in the review of the genus *Lutjanus* by Allen and Talbot (1985), this species has been reported from various localities, including the Arabian Sea (Manilo and Bogorodsky, 2003), the Andaman Sea (Satapoomin, 2009), Yaeyama Islands, Japan (Tanaka *et al*., 2010), northern part of the Gulf of Thailand (Satapoomin, 2013), and Papua New Guinea (Fricke *et al*., 2014).

More recently, Iwatsuki *et al*. (2015) reported that two distinct species with slightly overlapping distributions had been confused under *L. madras*, based on genetic and morphological analyses. They described one of those two species as a new species, *Lutjanus xanthopinnis* Iwatsuki, Tanaka & Allen, 2015, occurring in the Indo-West Pacific region (Sri Lanka to Indonesia and southern

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Table I. – Measurements and counts for *Lutjanus madras* and *L. xanthopinnis*. Means of measurements are in parentheses. *: not including soft flesh masses; **: right side.

	L. madras			*L. xanthopinnis*	
	This study	Iwatsuki *et al*. (2015)		Iwatsuki *et al*. (2015)	
	UPVMI 1084	Holotype	Non-types, n = 3	Holotype	Paratypes, n = 10
Measurements					
Standard length (SL; mm)	211.3	254	224-241	160	140-192
% of SL					
Body depth	34.8	32	34-37 (36)	39	34-38 (36)
Body depth at first anal-fin spine	31.8	29	29-30 (30)	34	29-34 (31)
Head length	37.6	38	38-40 (39)	36	37-40 (38)
Body width	15.1	18	13-15 (14)	14	15-18 (16)
Snout length	10.1	13	11-13 (12)	11	10-12 (11)
Orbit diameter	9.0	9	10-11 (10)	11	10-13 (12)
Interorbital width	11.1	9	8	7	6-7 (7)
Upper-jaw length	15.9	17	11-16 (14)	14	11-16 (15)
Caudal-peduncle depth	12.1	12	12	12	12
Caudal-peduncle length	14.4	17	18-19 (19)	19	18-21 (20)
Predorsal-fin length	41.2	39	40-42 (41)	40	37-44 (41)
Preanal-fin length	66.6	77	65-67 (66)	66	63-68 (65)
Prepelvic-fin length	41.7	44	40-41 (41)	38	36-42 (40)
Dorsal-fin base length	49.6	48	49-51 (50)	48	47-54 (51)
Anal-fin base length	15.7	15	15	15	13-15 (14)
Pelvic-fin spine length	11.6	10	12-14 (13)	14	12-21 (14)
Pelvic-fin length	20.4	17	21-22 (21)	23	19-23 (21)
Pectoral-fin length	28.6	26	27-31 (30)	31	28-34 (31)
First dorsal-fin spine length	3.8	4	5-6 (6)	6	5-6 (6)
Second dorsal-fin spine length	11.5	7	9-11 (10)	11	11-13 (12)
Third dorsal-fin spine length	13.6	10	13-14 (14)	13	14-16 (15)
Fourth dorsal-fin spine length	14.0	12	14-16 (15)	14	14-17 (15)
Fifth dorsal-fin spine length	13.1	12	14	14	13-16 (14)
Sixth dorsal-fin spine length	12.0	13	9-14 (12)	13	11-15 (13)
First dorsal-fin soft ray length	10.1	9	10-12 (11)	12	11-13 (12)
First anal-fin spine length	3.6	4	3-4 (4)	4	3-7 (5)
Second anal-fin spine length	9.8	9	10	12	11-14 (12)
Third anal-fin spine length	9.7	8	9-10 (10)	13	11-14 (12)
First anal-fin soft ray length	13.5	11	13-15 (14)	15	13-16 (15)
Counts					
Dorsal-fin rays	X. 13	X. 13	X. 13	X. 13	X. 13
Anal-fin rays	III. 9	III. 9	III. 9	III. 8	III. 8
Pectoral-fin rays	17	17	17	17	16-17
Lateral-line scales	47	50	49-51	48	48-50
Scale rows on cheek	8	8	7-8	4	4-5
Scale rows above lateral line	6 1/2	7 1/2	7 1/2	6 1/2	6 1/2-7 1/2
Gill rakers, upper limb total (rudiments)*	2 (0) / 3 (1)**	8 (6)	8-9 (7-8)	8 (7)	7-8 (6-7)
Gill rakers, lower limb total (rudiments)	15 (6) / 17 (7)**	17 (7)	17-18 (7-8)	14 (4)	14-15 (4-5)
Gill rakers, total (rudiments)*	17 (6) / 20 (8)**	25 (13)	25-27	22 (11)	22-23

Japan), and redescribed *L. madras* as being restricted to the Indian Ocean (Zanzibar to Sri Lanka).

The present study reports a single specimen [211.3 mm in standard length (SL)] of *L. madras* from Panay Island, Republic of the Philippines (Fig. 1), based on genetic and morphological comparisons of the specimen with those examined by Iwatsuki *et al.* (2015). This Philippine specimen represents the first record of *L. madras* from the Pacific Ocean, thereby extending its range across the Indo-Malay Archipelago, which is a well-established biogeographic barrier for a diverse array of marine organisms (*e.g.* Cowman and Bellwood, 2013).

MATERIALS AND METHODS

The present specimen was purchased at the Iloilo Central Market, Iloilo City, Panay Island, the Philippines, on 29 July 2014. It is highly unlikely that the specimen was imported from abroad: firstly, no single foreign fishing vessel is known to visit the Iloilo Fishing Port, where the fishes in the Iloilo Central Market are landed; secondly, the freshness and the volume of the fishes in the Iloilo Central Market indicate that they were caught just within the vicinity of Panay Island by small scale fishermen. Curatorial procedures of Motomura and Ishikawa (2013) were followed, and the specimen was deposited in the Ichthyological Collection of UPV Museum of Natural Sciences, University of the Philippines Visayas (UPVMI), bearing the registration number UPVMI 1084. Measurements and counts followed Allen and Talbot (1985) and Iwatsuki *et al.* (1993). Institutional codes followed Sabaj Pérez (2016). One of the specimens used to redescribe *L. madras* (MUFS 42914, 226.0 mm SL, Beruwala, Sri Lanka, 6°29'2"N, 79°59'0"E) (Iwatsuki *et al.*, 2015) was examined as a comparative material.

Total genomic DNA of the present specimen was extracted from a fin clip, preserved in 99.5% ethanol, using the Wizard Genomic DNA Purification Kit (Promega) following the manufacturer's protocol. Approximately 650 bp from the 5' end of cytochrome c oxidase subunit I (*COI*) gene of mitochondrial DNA (mtDNA) was amplified with a primer cocktail comprised of four (*i.e.* two sets of forward and reverse) primers ["COI-3" in Ivanova *et al.* (2007)]. Polymerase chain reaction (PCR) was conducted in an 8.0 μl reaction volume containing 4.0 μl of 2× EmeraldAmp PCR Master Mix (TaKaRa), 0.125 μM of each primer, and 1.0 μl (approximately 50 ng) of template DNA. The PCR conditions included initial denaturation at 94°C for 2 min, followed by 35 cycles of denaturation at 94°C for 30 s, annealing at 52°C for 40 s, and extension at 72°C for 1 min, and a final extension at 72°C for 10 min. The PCR products were purified with ExoSAP-IT (Affymetrix). DNA sequencing was performed using the Big-Dye Terminator Cycle Sequencing Kit v.3.1 (Life Technologies) on an Applied Biosystems 3500 Genetic Analyzer (Life Technologies). The resulting sequence was edited with BioEdit 7.0.5.3 (Hall, 1999) and archived in GenBank (accession number LC216212). The sequence was aligned with three and five additional sequences of *L. madras* (accession numbers LC071440, LC075757 and LC075758) and *L. xanthopinnis* (LC071439, LC071441, LC071442, LC075755 and LC075756), respectively, determined by Iwatsuki *et al.* (2015), using CLUSTAL X (Larkin *et al.*, 2007). Pairwise sequence divergence between specimens was calculated using the uncorrected *p*-distance, as implemented in MEGA 6 (Tamura *et al.*, 2013).

RESULTS AND DISCUSSION

Measurements and counts are shown in table I. The present specimen agrees well with *Lutjanus madras* as described by Iwatsuki *et al.* (2015), in characters including the number of fin rays and most of the proportional measurements. Specifically, the specimen is distinguishable from *L. xanthopinnis* by having no scales on the preopercular flange (vs. embedded scales present in *L. xanthopinnis*), eight scale rows on the cheek (vs. four or five), a low flap on the anterior nostril (vs. lacking conspicuous flap on either nostril), and a broad, well-contrasted yellow stripe along the lateral midline when fresh (vs. mostly uniformly thin yellow to brownish stripes) (Fig. 2). Furthermore, the genetic analysis clearly revealed the lack of differentiation from the specimens of *L. madras* and greater divergence from the specimens of *L. xanthopinnis*. The average pairwise divergence, estimated from 608 bp of *COI* gene sequence of the present specimen, from those of *L. madras* and *L. xanthopinnis*, was 0.0022 (range: 0.0000-0.0049) and 0.0679 (range: 0.0659-0.0692), respectively. The morphological and genetic analyses thus clearly indicate that the present specimen is *L. madras*, representing the first record of this species from the Pacific Ocean. The species, previously thought to be restricted to the Indian Ocean, is therefore likely to be distributed widely in the Indo-West Pacific region.

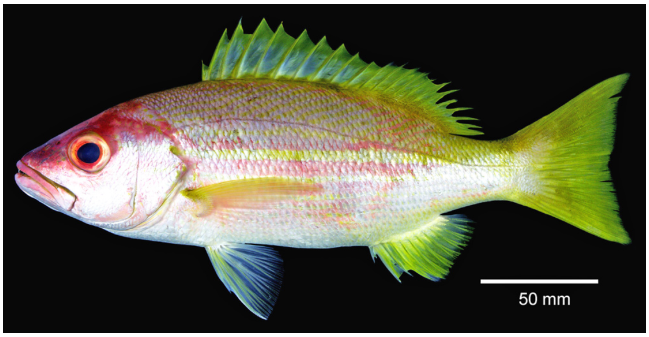

Figure 2. – Fresh specimen of *Lutjanus madras* (UPVMI 1084, 211.3 mm SL, Panay Island, Republic of the Philippines).

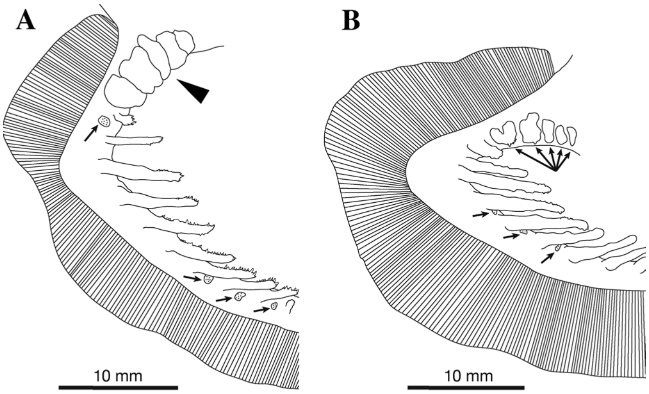

Figure 3. – Diagrams of the first gill arch of the right side of *Lutjanus madras*. **A**: UPVMI 1084; **B**: MUFS 46214 (226.0 mm SL, Beruwala, Sri Lanka). Arrowhead and arrows indicate soft flesh-like mass and rudimentary gill rakers, respectively.

Besides the close similarities mentioned above, minor differences were observed in some characters between the present specimen and those of *L. madras* described by Iwatsuki *et al.* (2015). These include the caudal-peduncle length, the number of lateral-line scales, and the number of the scale rows above the lateral line (Tab. I). In addition, the present specimen possesses a soft flesh-like mass on the upper limb of the first gill arch that is segmented into several parts (Fig. 3), instead of rudimentary rakers observed in the other specimens of the species (Iwatsuki *et al.*, 2015). We consider these differences to be intraspecific variation. However, it is still uncertain whether they represent geographic variation between sub-populations, or an individual-level variation within a single gene pool. The significance of the observed peculiarity of the present specimen needs to be addressed in a future study, based on a more extensive sampling across the Indo-West Pacific region, especially in the Pacific Ocean, which should be aimed at clarifying the detailed geographic population structure of the species.

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